CLAIMS

1.   A method of discrete multitone transmission of bits making up a plurality
of frames including:

allocating a respective number of bits to each of a plurality of discrete
tones;

assigning the bits of each frame to the discrete tones such that each
discrete tone is assigned the allocated respective number of bits, wherein the
permutation mapping the bits of each frame to each of the discrete tones
cycles through a sequence of different permutations in successive frames;

generating for each frame a symbol comprising a plurality of discrete
tones modulated to transmit the bits assigned to the respective tones; and

transmitting the generated symbols.

2.   A method of data transmission according to claim 1 wherein a different
permutation is used in each successive frame.

3.   A method of data transmission according to claim 1 wherein a
predetermined cyclic sequence of permutations is used in successive frames.

4.   A method of data transmission according to claim 1 wherein
there are n discrete tones, where n is an integer;
the ith tone is allocated to transmit b(i) bits, where b(i) is an independent
positive integer for each of the n tones; and

in the jth frame each consecutive $b(n_{jk})$ bits starting from the first bit of
the frame are assigned to the n_{jk}th tone in sequential order as k increases from
1 to n, where $[n_{j1}, n_{j2}, n_{j3}, ... n_{jn}]$ is a permutation of the first n positive integers
[1, 2, 3 .... n].

5.   A method of data transmission according to claim 4 wherein the
sequence of permutations cycles from an initial permutation through all
possible permutations of the first n integers [1,2,3 ... n] in successive frames
before returning to the initial permutation to commence the cycle again.

6.   A method of data transmission according to any preceding claim including

for each of the discrete tones generating for each frame an amplitude phase keyed constellation point representing the bits allocated to the tone; and

using an inverse discrete Fourier transform to generate a transmitted output signal from the amplitude phase keyed constellation points.

7.   A method of data transmission according to claim 6 wherein the amplitude phase keyed constellation points are quadrature amplitude modulation constellation points.

8.   A method of data transmission according to any preceding claim wherein the bits are trellis coded.

9.   A discrete multitone modem for transmitting a stream of bits making up a plurality of frames, comprising:

a tone generator for assigning the bits in each frame to discrete tones such that each discrete tone is allocated a predetermined respective number of bits, wherein the permutation mapping the bits of each frame to each of the discrete tones cycles through a sequence of different permutations in different frames;

a constellation point generator for generating a constellation point for each tone representing the assigned bits; and

an inverse discrete Fourier transform module for generating an output signal including a plurality of discrete tones from the constellation points.

10.   A discrete multitone modem according to claim 9 for use with n discrete tones, where n is an integer, wherein

the tone generator includes a bit allocation table allocating $b(i)$ bits to the ith tone, where $b(i)$ is an independent positive integer for each of the n tones; and

the tone generator assigns in the jth frame the first $b(n_{j1})$ bits of the bit stream to the n_{j1}th tone, and each subsequent $b(n_{jk})$ bits are assigned to the

n_{jk}th tone in sequential order as k increases from 1 to n, where [n_{j1}, n_{j2}, n_{j3}, ... n_{jn}] is a permutation of the first n positive integers [1, 2, 3 .... n].

11.   A discrete multitone modem according to claim 10 wherein the sequence of permutations cycles from an initial permutation through all possible permutations of the first n integers [1,2,3 ... n] in successive frames before returning to the initial permutation to commence the cycle again.

12.   A method of receiving data divided into frames, the data being generated by assigning the bits of each frame to discrete tones and mapping the bits of each frame to the discrete tones by cycling through a predetermined sequence of different permutations in successive frames; wherein the method includes the steps of:

receiving a sequence of symbols, each symbol frame including a respective number of bits on each of a plurality of discrete tones;

decoding the transmitted bits; and

inverting the predetermined permutation corresponding to each frame to regenerate the transmitted bits of the frames.

13.   A method according to claim 12 wherein there are n discrete tones, where n is an integer, the ith tone being allocated to transmit b(i) bits, where b(i) is an independent positive integer for each of the n tones; the method comprising the steps of

obtaining for each frame (j) the permutation [n_{j1}, n_{j2}, n_{j3}, ... n_{jn}] of the first n positive integers [1, 2, 3 .... n], and

regenerating the frame by taking the first b(n_{j1}) bits of the frame from the decoded n_{j1}th tone, and the subsequent bits in order from the decoded n_{j2}th tone, the n_{j3}th tone until the last bits are taken from the n_{jn}th tone.

14.   A discrete multitone modem for receiving a stream of symbols representing a plurality of frames, comprising:

a discrete Fourier transform module for generating constellation points corresponding to discrete tones contained in each received symbol;

a tone decoder for making up a frame such that each discrete tone is allocated the respective number of bits, wherein the allocation of bits to discrete tones cycles through a sequence of different permutations in different frames, and for generating a constellation point representing the allocated bits
5 for each tone; and

an inverse discrete Fourier transform module for generating an output signal including a plurality of discrete tones from the constellation points.

15. A method of data transfer of bits making up a plurality of frames across
10 a link, comprising

allocating a respective number of bits to each tone;

assigning the bits of each frame to the discrete tones such that each discrete tone is assigned the allocated respective number of bits, wherein the permutation mapping the bits of each frame to each of the discrete tones
15 cycles through a sequence of different permutations in successive frames;

generating for each frame a symbol comprising a plurality of discrete tones modulated to transmit the bits assigned to the respective tones;

transmitting the generated symbols across a link;

receiving the transmitted symbols;
20 decoding the transmitted bits in each tone; and

inverting the mapping of bits to tones corresponding to each frame to regenerate the original frames from the decoded bits of each tone.

16. A method according to claim 15 wherein there are n discrete tones,
25 where n is an integer, the ith tone being allocated to transmit $b(i)$ bits, where $b(i)$ is an independent positive integer for each of the n tones;

and the step of mapping tones to bits assigns in the jth frame the first $b(n_{j1})$ bits of the frame to the n_{j1}th tone, and each subsequent $b(n_{jk})$ bits are assigned to the n_{jk}th tone in sequential order as k increases to n, where $[n_{j1}, $
30 $n_{j2}, n_{j3}, \ldots n_{jn}]$ is a permutation of the first n positive integers $[1, 2, 3 \ldots n]$.